

# **CORES – Complex Organizational Reasoning System<sup>1</sup>**

## **CASOS Technical Report**

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### **Abstract**

In Operations Other Than War (OOTW), there is a need for intelligence analysts and military planners to anticipate the actions and responses of complex networked organizations such as terrorist groups, nation-states and key actors (such a high-level leaders). The Complex Organizational Reasoning System (CORES) is a multi-agent network simulation model that uses organizational, social, political and economic dynamics to generate predictions of the likely actions and responses of these actors when involved in an adversarial context.

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## **CASOS Technical Report**

The anticipated benefits of CORES are that it will enable the user to anticipate key hostile activities, thus neutralizing the enemy's ability to surprise. Additionally, it will enable the user to reason through potential courses of action using "What-if" analysis capabilities to estimate alternative and likely responses. Finally, it will enable the user to test the efficacy of plans for influencing others. CORES advances the state of the art in political actor research by integrating models of social influence, organizational structure, social networks, and resource dependency in a strategic decision context. Potential areas of application include military intelligence and learning, political and corporate negotiation, disaster relief and crisis management, and business intelligence.

### **1. Model Description**

CORES is a multi-agent network model of strategic decision making that generates predictions based on conflict scenarios. The scenarios are represented within a framework consisting of Actors, Resources, Goals, Actions, Effects and Relations. Based on these entities, the model generates predictions of likely actions and responses of actors.

#### **1.1 Actors**

Actors are the players or participants in the conflict. The attributes associated with an actor are:

- **Volatility:** constrained between 0 and 1. Indicates how an actor responds to changes in hostility. An actor with a volatility of 0 will never change hostility; an actor with a volatility of 1 will change hostility by the full magnitude of hostility changes.
- **Tension Threshold:** Constrained between 0 and 1, based generally on the hostility scale. Indicates at which negative hostility value or greater an actor will retaliate against another actor. The magnitude (absolute value) of negative hostility values is compared to the tension threshold to determine which actors may be retaliated against. For example, an actor with a hostility of -.9 towards another actor and a tension threshold of .8 will retaliate against that actor; but if it had a hostility of -.7 would not.

#### **1.2 Goals**

Goals are things actors aim toward. Examples include curbing terrorism, increasing Arab power, gaining Palestinian sovereignty/independence, etc. These are coded by the scenario developer based on stated or reasoned goals of various actors.

### 1.3 Actions

Actions are things that actors can do. Examples include Israel Invades Palestinian Territory, Suicide Bomb, Provide Humanitarian Relief, Call for peace Talks, etc. These are coded by the scenario developer into a scenario specific response field; actions available will differ widely depending on nature of scenario and nature of actors. Actions have the following attributes:

- Duration: determines how long after the decision is made to take the action until the effects take place.
- Category: currently must be one of the following: Military, Diplomatic, Financial Economic, or Humanitarian.
- Sender: the actor who initiates this action
- Receiver 1: primary receiver of the action.
- Receiver 2,3,4,etc: possible secondary receivers of the action

### 1.4 Resources

Resources are things that Actors have. Examples include Israeli Money, Land in Gaza Strip, Land in West Bank, American Casualties, etc. Resources have the following attributes:

- Growth Rate: is the amount by which the resource increases/decreases every time period.

### 1.5 Effects

Effects are the results of actions. An example of action/effect pair is Israel Invades Palestinian Territory causes Israeli money to decrease by the amount used up in the invasion.

### 1.6 Relations

The model framework includes the following entity relationships:

- Actor by Actor relations

There are two types of Actor by Actor relations:

- Hostility: Indicates degree of enmity between actors.
- Influence: Indicates amount of effect an actor has on other actors.

- Actor by Goal relation

This is the amount an actor believes in/values/wants to achieve a specific goal.

- Actor by Action relations

There are two types of Actor by Action relations:

- Tendency: Indicates the initial likelihood of an actor taking a particular action.
- Belief: Indicates the initial belief that an actor has in an action.

- Resource by Actor relation

This is the amount of a particular resource that an actor possesses initially.

- Goal by Resource relation

This indicates how much changes in resources correlate with specific goals. Since changes in resources are essentially effects, this relation can also be viewed as a *Goal by Effect* relation.

- Action by Resource Requirement relation

This is the amount of a particular resource that is required to carry out a particular action.

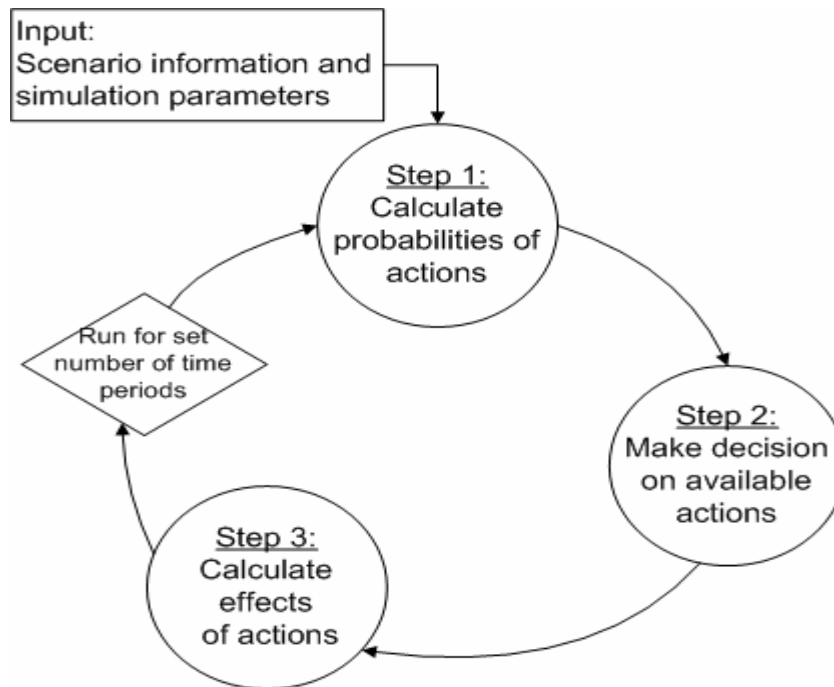
- Action by Effect relation

This is the effect of a particular action. Since effects are essentially resource changes, this can be viewed as the effect on resources of a particular action. Note: sometimes an action will require certain resources but will not deplete those resources when carried out. This can be achieved by putting the resource requirement in the Action by Resource Requirement relation and leaving it out of the Action by Effect relation.

## 1.7 Workflow

The CORES model, as written, is suited for modeling in a computer simulation as it describes complex, multi-agent, non-linear, dynamic behavior.

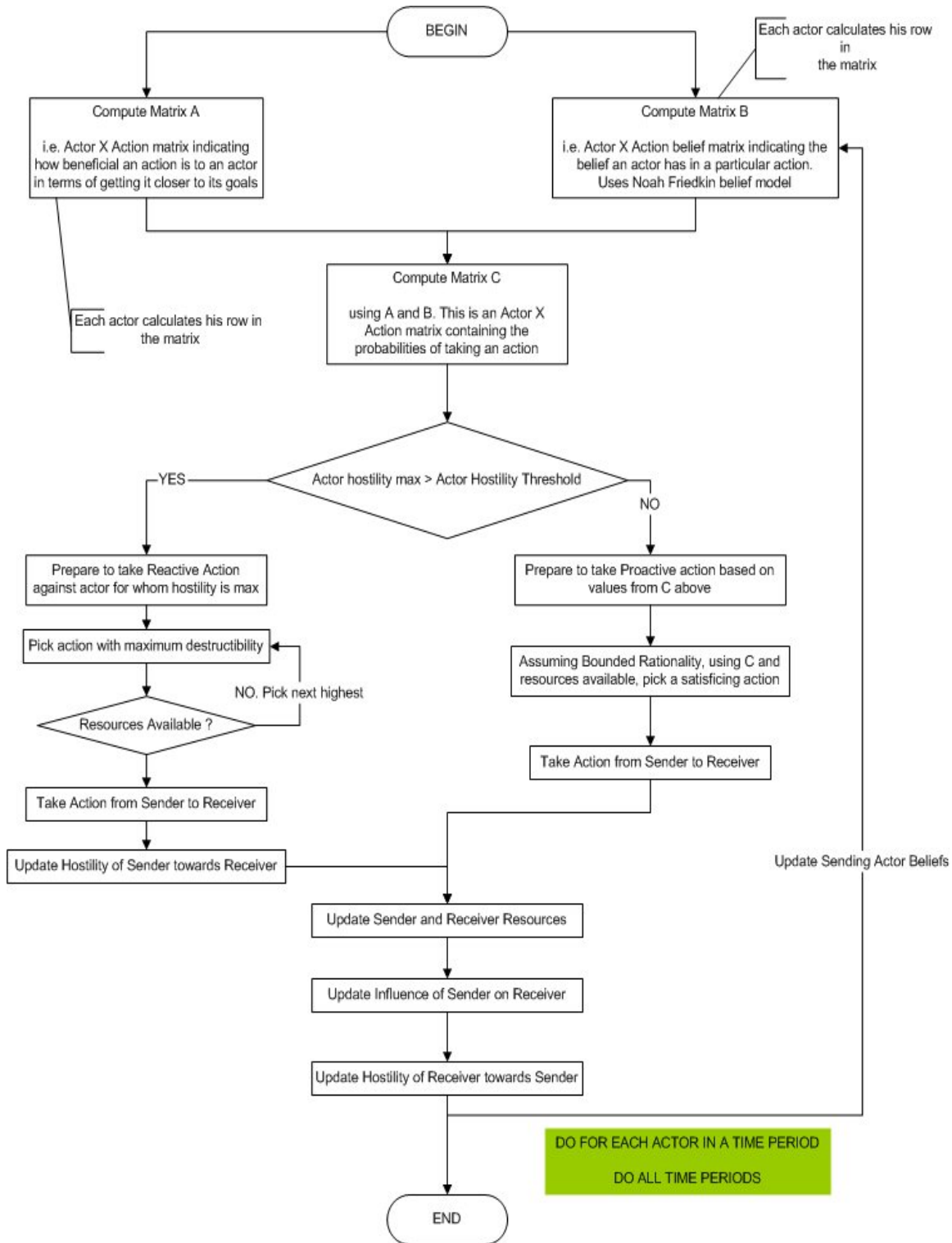
In order to develop a simulation from the model, two primary modules have been implemented - a module to describe the decision that actors actually take, and a module to update the scenario state based upon the effects of the decisions made.



**Figure 1: CORES - Overall Model Workflow**

Steps 1 and 2 from Figure 1 describe the decision taking process and Step 3 describes the update process.

Below is the detailed flow diagram of the CORES simulation:



**Figure 2: CORES - Detailed Model Workflow**

The following steps constitute the execution of a typical run in a scenario:

- 1) An actor computes how beneficial actions are to him in terms of getting him closer to his goals.
- 2) Then, using the Noah Friedkin Belief Model, the actor computes his belief in the various actions.
- 3) Based on values from steps 1 and 2, the actor computes probabilities of taking various actions.
- 4) Next is a decision point, where if the actor's (sender) hostility towards any other actor (receiver) is greater than his (sender's) tension threshold, he (sender) reacts and takes a hostile (reactive) action towards the receiver. This is contingent upon the sender having enough resources to take the reactive action. Also the hostility of Sender towards receiver is adjusted.
- 5) If the all the hostilities are below the tension threshold, the actor prepares to take a proactive action. In this case, assuming bounded rationality, the actor evaluates a subset of the available actions and executes the most beneficial one.
- 6) After either step 4 or 5, Sender and Receiver resources are updated, the influence of Sender on Receiver is updated and the hostility of Receiver towards Sender is updated.
- 7) This is done for each actor in the scenario.
- 8) This is repeated for all time periods.

*Notes:*

- 1) Every time period the actor will decide whether or not to take an action. The actor will not take an action if the actor does not have enough resources to take an action. The actor will not take an action if the probability of taking an action is too low. An action "take no action" could be coded into the scenario, but it must be coded as such to make it favorable to the actor to take it.
- 2) The actor can start at most one action every time period, but since actions have duration certain actions will not end in the same time period that they are started. Actions can span multiple time periods. This means that an actor can start an action in one time period and it will not end until several time periods later. In the mean time the actor could have started several other actions. The number of actions an actor can have running at the same time is only limited by the actor's resources.

3) When an action is started its effect on the sender (the actor who starts the action) is felt in the time period that the action is started. However the effect of the action on the receivers is not felt until the time period that the action ends.

## 2. Program Execution

The CORES system runs as an executable called cores.exe. There is only one command line parameter to this executable which is the full path of a configuration file. Thus a sample command to run cores would be:

e.g. C:\TestDir>cores.exe ConfigurationFile.txt

assuming both cores.exe and ConfigurationFile.txt are in the TestDir folder.

Currently CORES uses csv files for input. The input filenames, output filenames, what output to create, and how to format the output is configured through the configuration file.

### 2.1 Sample Configuration File

Here is a sample configuration file:

```
#one line per statement
# lines starting with # are comments
#
```

#### [SIMULATION PARAMETERS]

```
input type = FILES
#input type = DATABASE
dbName = coresDB
dbUID = userX
dbPWD = 1122345
dbServerName = windtalker.wv.cs.cmu.edu
number of runs = 1
number of time periods = 26
# Make sure you put the final directory delimiter
# on the input and output directories!
input directory = C:\Documents and Settings\kf3cr\My Documents\normalIntifada\
output directory = C:\Documents and Settings\kf3cr\Documents\normalIntifadaOutput\
```

#### [INPUT TABLE NAMES]

```
action x effect = actionBYeffect
action x resource requirement = actionBYresourceReq
action details = actionDetails
```

actor x goal = actorBYgoal  
actor x resource = actorBYresource  
beliefs = beliefs  
goal x effect = goalBYeffect  
hostility = hostility  
influence = influence  
injected actions = injectedActions  
tendencies = tendencies  
tension threshold = tensionThreshold  
volatility = volatility

[INPUT FILE PATHS]

action x effect = actionBYeffect.csv  
action x resource requirement = actionBYresourceReq.csv  
action details = actionDetails.csv  
actor x goal = actorBYgoal.csv  
actor x resource = actorBYresource.csv  
beliefs = beliefs.csv  
goal x effect = goalBYeffect.csv  
hostility = hostility.csv  
influence = influence.csv  
injected actions = injectedActions.csv  
tendencies = tendencies.csv  
tension threshold = tensionThreshold.csv  
volatility = volatility.csv

pause injections = pauseInjectionsFile.csv  
#pause injections =

[OUTPUT FILE PATHS]

timeSummaryFile=timeSummaryOutput.txt  
#actResourceFile=  
hostilityMatFile=hostilityMatOutput.txt  
influenceMatFile=influenceMatOutput.txt  
beliefsMatFile=beliefsOutput.txt  
actionTendFile=actionTendOutput.txt  
probActionMatFile=probActionMatOutput.txt  
actBenefitMatFile=actBenefitMatOutput.txt

actorResourceFile =Israel;IsraelResources.txt  
actorResourceFile = Hamas;HamasResources.txt

actorDeltaResourceFile = Israel;IsraelDeltaResources.txt

#### [OUTPUT FLAGS]

```
print names    = true
print format = CSV
#print format = NORMAL
```

```
timeSummary=true
#actResource=false
hostilityMat=true
influenceMat=true
beliefsMat=true
actionTend=true
probActionMat=true
actBenefitMat=true
```

```
actorResourceFlag=Israel;true
actorResourceFlag=Hammas;true
actorDeltaResourceFlag = Israel;true
```

## 2.2 General Format of Configuration File

Here is a description of the general format of the configuration file:

Any line that starts with '#' is a comment and is ignored. Empty lines are allowed.

Each line is a variable and its assigned value, example: actBenefitMat=true. Here we see the actBenefitMat variable being assigned to true.

Not all variables are necessary for a simulation run, but some are. The variables that are absolutely necessary are those in the input file paths section. These variables must be in the configuration file along with values for each. The mandatory variables are:

```
action x effect = actionBYeffect.csv
action x resource requirement = actionBYresourceReq.csv
action details = actionDetails.csv
actor x goal = actorBYgoal.csv
actor x resource = actorBYresource.csv
beliefs = beliefs.csv
goal x effect = goalBYeffect.csv
hostility = hostility.csv
influence = influence.csv
injected actions = injectedActions.csv
tendencies = tendencies.csv
tension threshold = tensionThreshold.csv
volatility = volatility.csv
```

The values on the right of these mandatory values are CSV files. They will be discussed in detail later. All of the sections of the configuration file will now be explained.

### 3. System Input

The configuration file contains four sections namely: Simulation Parameters, Input File Paths, Output File Paths, and Output Flags. The first two are input related and the latter two configure the output. Here is a detailed description of the input related sections of the Configuration File:

#### 3.1 Simulation Parameters Section

The simulation parameters section contains three variables:

```
number of runs = 1
number of time periods = 26
input directory = C:\path\to\IO\files
output directory = C:\path\to\IO\files
```

- number of runs

This is the number of runs over which the results will be averaged. It is assumed to be one if it is not set in the configuration file. If it is set in the configuration file, the simulation will use that.

- number of time periods

This is the number of time periods in a run. It is assumed to be 5 if it is not found in the configuration file.

- input directory

This is the path that is prepended to all input filenames (in the input file paths section, discussed next) specified in the configuration file. The “input directory” variable essentially tells CORES where to look for the input files. The path to the files could also be specified when each file is specified, but if the location of the file changes, then each line in the configuration file must be changed. With the “input directory” variable only one line has to be changed if the file locations change.

- output directory

This is the path that is prepended to all output filenames (in the output file paths section, discussed under System Output) specified in the configuration file. The “output directory” variable essentially tells CORES where to look for the input files. The path to the files could also be specified when each file is specified, but if the location of the file

changes, then each line in the configuration file must be changed. With the “output directory” variable only one line has to be changed if the file locations change.

### 3.2 System Input from a MySQL Database

Cores can use a MySQL database as its input source as an alternative to the csv input files. Cores must have several important variables set in its configuration file before it can use a database. The MySQL database and the client machine (the one running cores) must be configured properly as well.

#### 3.2.1 Cores Configuration File Variables

The following variables must be set in the SIMULATION PARAMETERS section:

```
#input type = FILES
input type = DATABASE
dbName = coresDB
dbUID = userX
dbPWD = 12345678
dbServerName = someMachine.someDomain.com
```

Note that there are two “input type” lines, but one of them is commented out. The commented line shows how to configure cores to use files as its input. The default input type is files, but it is always good to explicitly set the desired type. If the input type is set to DATABASE all the parameters in the INPUT TABLE NAMES section will be considered and those in the INPUT FILE PATHS section will be ignored. If the input type is set to FILE it is vice versa.

- dbName

This is the name of the database within the MySQL database management system that has the input. This should be available from the MySQL administrator.

- dbUID, dbPWD and dbServerName

These are the username, password, and server name for the MySQL server. Again, all of these should be available from the MySQL administrator. Note that the password is not stored in any type of encrypted format. This means that anybody who can read the configuration file for cores can logon and query the database. Make sure that the admin does not give this user privileges to edit the database.

Note: The dbName variable corresponds to the “Database Name” field in the MyODBC driver configuration window (see below). dbUID corresponds to the “User” field, and dbServerName corresponds to the “Host/Server Name” field. In a future release of CORES a dbPort variable will probably be available as well that would correspond to the “Port” field in the MyODBC configuration window.

The INPUT TABLE NAMES section must look something like this:

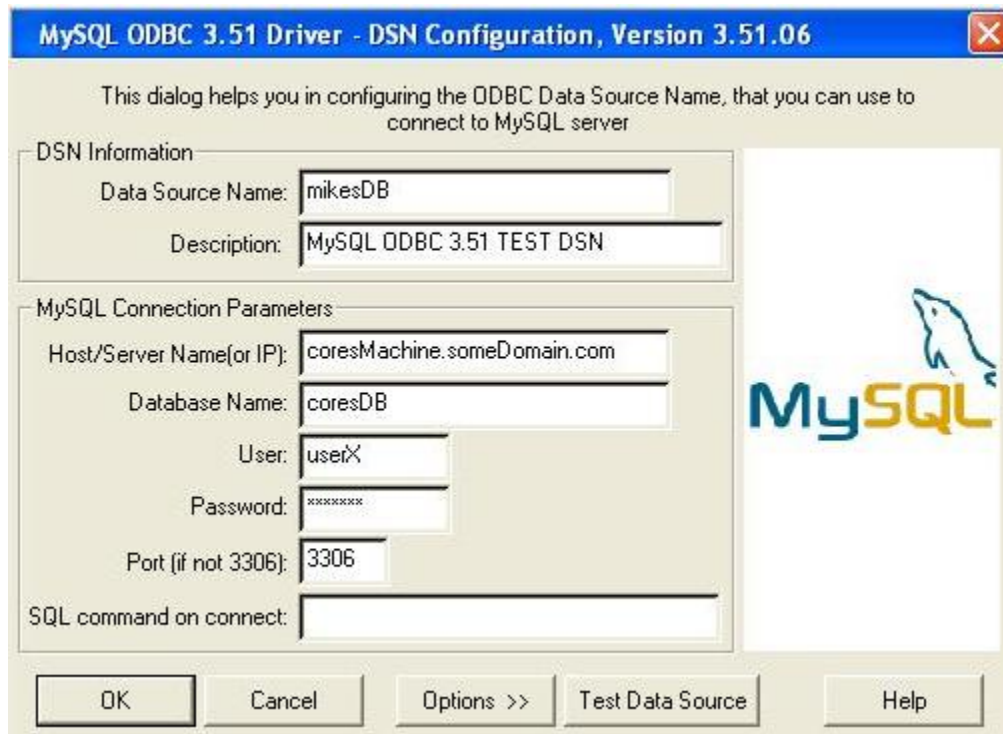
action x effect = actionBYeffect  
action x resource requirement = actionBYresourceReq  
action details = actionDetails  
actor x goal = actorBYgoal  
actor x resource = actorBYresource  
beliefs = beliefs  
goal x effect = goalBYeffect  
hostility = hostility  
influence = influence  
injected actions = injectedActions  
tendencies = tendencies  
tension threshold = tensionThreshold  
volatility = volatility

On the left of the above list is the variable names which must be spelled exactly like this. The right side has the table names in the database. These names can be anything as long as they match up with the proper tables in the database.

### 3.2.2 Client Machine Configuration

To configure a client machine to connect to a MySQL database the [MyODBC-3.51.06.exe](#) driver must be installed. This driver can be found on the MySQL website, [www.mysql.com](http://www.mysql.com). Once the driver is installed it must be configured to use the database:

1. Run the standard windows program “odbcad32.exe” from a command prompt. This will open the “ODBC Data Source Administrator” window.
2. Select the MySQL ODBC driver and hit the “configure...” button. This will open the MyODBC configuration window. The information in this window can be obtained from the MySQL database administrator. Make sure that the info in this window matches the info in the Cores configuration file. Below is a screen shot of the MyODBC window:



**Figure 3: Client Side Database Configuration**

### 3.2.3 MySQL Database Configuration

The database must have tables that match fairly close to the format of the files used in the file input method. The column names of the tables must correspond to the column names used in the csv input files. One problem with MySQL is that it cannot have spaces in column names. This means that quite a few things in the simulation cannot have spaces in the name. These include, effect names, goal names, actor names, action names, and resource names.

An example table in the database is the tendencies table. It must have a column for each action available in the simulation. Each row must start with an actor name and then a varchar for each element of the matrix.

Note that the first column of ALL tables in the database MUST be “START MATRIX.”

### 3.3 Input File Paths Section

Next is the input file paths section. This section is mandatory. A file must exist for each of these variables in order to do a simulation. Currently all these files need to be csv files. Following is a description of the variables in this section:

- action x effect

This is the name of the file that contains the effects of various actions in the simulation. It is a csv file containing an action by effect matrix such that there are action rows and resource columns. Each element in this matrix indicates how much a resource is incremented or decremented as a result of the corresponding action. For a sample file see actionBYeffect.csv in the Sample Files folder shipped with CORES.

Thus the entry for action x effect would look like:

action x effect = actionBYeffect.csv

- action x resource requirement

This is the name of the file that contains the resource requirements for actions. It is a csv file containing an action by resource matrix. This matrix shows how much of each resource is required before an action can be taken. These values should all be positive. These values do not show any information on the effect of an action on resources. It just shows that the resources must exceed a certain level before the action is taken. For a sample file see actionByresourceReq.csv in the Sample Files folder shipped with CORES. Thus the entry for action x resource requirement would look like:

action x resource requirement = actionBYresourceReq.csv

- action details

This is the name of the file that contains the action details. It shows the category, duration, sender, and receivers of each action. The category is currently not used by CORES, but it is required. The four category choices are “Military,” “Financial Economic,”

“Humanitarian,” and “Diplomatic.” Duration is the number of time periods required for the action to be deemed complete. Each time period can be viewed as (roughly) equivalent to a day. The sender should be an actor. There must be at least 1 receiver.

The first receiver listed is the primary receiver. This is important for hostile actions. For a sample file see actionDetails.csv in the Sample Files folder shipped with CORES.

Thus the entry for action details would look like:

action details = actionDetails.csv

- actor x goal

This is the name of the file that contains goal weights for the simulation actors. It is a csv file containing an actor by goal matrix with actor rows and goal columns. Each element of the matrix denotes how important a goal is to the corresponding actor. The more important a goal is the more positive the value. The sum of all the values in a row must equal 1.0.

For a sample file see actorBYgoal.csv in the Sample Files folder shipped with CORES.

Thus the entry for actor x goal would look like:

actor x goal = actorBYgoal.csv

- actor x resource

This is the name of the file that contains initial actor resources and their growth rates every time period. If the resource should not grow automatically then make the growth 0.0. For every resource that an actor DOES NOT have, make its value -1.0.

For a sample file see actorBYresource.csv in the Sample Files folder shipped with CORES.

Thus the entry for actor x resource would look like:

actor x resource = actorBYresource.csv

- beliefs

This is the name of the file that contains each actor's initial beliefs in the various actions. Currently they are set to 1 indicating that actors are neutral to all actions at the start of the simulation. For a sample file see beliefs.csv in the Sample Files folder shipped with CORES.

Thus the entry for beliefs would look like:

beliefs = beliefs.csv

- goal x effect

This is the name of the file that contains the correlation between goals and effects. The better an effect is for a goal the more positive the value. The worse an effect is for a goal the more negative the value. The rows do not have to sum to one. For a sample file see goalBYeffect.csv in the Sample Files folder shipped with CORES.

Thus the entry for goal x effect would look like:

goal x effect = goalBYeffect.csv

- hostility

This is the name of the file containing the initial actor hostility matrix. It shows an actor's initial hostilities towards other actors. The values must be between -1 and 0 (both inclusive). The more negative a value, the more hostile the row actor is towards the column actor. For a sample file see hostility.csv in the Sample Files folder shipped with CORES.

Thus the entry for hostility would look like:

hostility = hostility.csv

- influence

This is the name of the file containing the initial actor influence matrix. It shows the influence all the actors have on a particular actor. The values must be between 0 and 1 (both inclusive) and rows must sum to one. The more positive a value is the more influence a column actor has on the row actor. For a sample file see influence.csv in the Sample Files folder shipped with CORES.

Thus the entry for influence would look like:

influence = influence.csv

- injected actions

This is the name of the file containing events that should be injected into the simulation at specified time periods. It is not a matrix. There are two types of injected events. Actions can be injected by specifying the time period the action is to happen, the actor who is to take the action, and the action. The other type of injected event is a resource change. The time period, the actor whose resources are to change, the resource, and the amount of change need to be specified. For a sample file see injectedActions.csv in the Sample Files folder shipped with CORES.

Thus the entry for injected actions would look like:

injected actions = injectedActions.csv

- tendencies

This is the name of the file containing initial action frequencies for the various actors. The frequencies would typically be based on real life history of the actor. The rows should sum to one. For a sample file see tendencies.csv in the Sample Files folder shipped with CORES.

Thus the entry for tendencies would look like:

tendencies = tendencies.csv

- tension threshold

This is the name of the file containing tension threshold values for actors. Threshold is the level of tension that actors are willing to endure before they start taking retaliatory actions. The value should be between 0 and 1(both inclusive). Actors will take retaliatory actions against other actors whose hostility magnitude go above the tension threshold. For example if actor AAA's hostility toward actor BBB is -0.7999, and actor AAA's tension threshold is 0.8. If actor BBB takes an action toward AAA that takes AAA's hostility toward BBB more negative than -0.8, actor AAA will take a retaliatory action toward BBB. For a sample file see tensionThreshold.csv in the Sample Files folder shipped with CORES.

Thus the entry for tension threshold would look like:

tension threshold = tensionThreshold.csv

- volatility = volatility.csv

This is the name of the file containing actor volatility values. Volatility is used after an actor takes a retaliatory action. The more volatile an actor is the more his hostility will go down after he takes a retaliatory action. Volatility must between 0 and 1.0. For a sample file see volatility.csv in the Sample Files folder shipped with CORES.

Thus the entry for volatility would look like:

volatility = volatility.csv

## 4. System Output

The system output consists of information from the simulation at the end of every time period. This allows the researcher to see the order of events and why they came to be. Output will be either a matrix of some kind or some actor relevant information. Next is a detailed description of the output relevant sections in the configuration file:

### 4.1 Output Flags Section

The output flags section contains flags to turn on/off different types of output. Most of these have to do with printing. Even though a path to an output file is assigned (discussed in the next section), nothing will be printed into the file unless the proper output flag is set to true. Note that all flags that are not explicitly set to true in the configuration file will be assumed to be false by CORES.

Along with the flags to tell what output to print there are two flags that decide how to print. They are “print names” and “print format.” If “print names” is assigned true then the column and row names of the matrices will be printed each time a matrix is printed to file. This can be useful if the output files will be viewed directly. Printing the row and column names might not be desirable if some statistics program will be used on the output files. “print format” is special in that it does not take true or false values. Instead it takes “CSV” or “NORMAL.” The default is “NORMAL”. This controls what delimiter is used between the fields in the outputs. If “print format” is set to “NORMAL” the delimiter is a space, but if “print format” is set to “CSV” the delimiter will be a comma. Using CSV is recommended if any of the names used in the simulation will have spaces in them. If there are spaces in the names of Actions or Actor names and spaces are used to delimit fields in the output, it makes the output difficult to read. CSV is the recommended format.

“actorResourceFlag” is a special flag inside the output flags section. The format for it is: actorResourceFlag = XXX; true. This tells CORES to print out the resources of actor XXX every time period. There can be more than one actorResourceFlag line depicting a particular actor in the simulation.

### 4.2 Output File Paths Section

The last section in the configuration file is the output file paths section. An entry for a variable in this section is mandatory only if the corresponding output type flag has been turned on in the previous section. Here is a detailed description of each variable in this section:

- timeSummaryFile

This is the name of the file that contains information on what each actor does each time period. Each entry in the file has the following format:

1, 1, Palestinians, START ACTION Palestinians Call For Support From US, United States, proactive, Probability: 0.234310

The first field indicates the run number which in this case is 1. The next field (separated by a comma) is the time period which is again 1. This is followed by the sending actor i.e. Palestinians. Next are the details of the action that the sending actor takes. This is broken down into two parts: the keyword START ACTION indicates that the actor starts the action in the current time period, followed by the name of the action i.e. START ACTION Palestinians Call For Support From US. The next field is the receiving actor i.e. United States. This field is followed by the field that shows if the action was a proactive action (self benefit action) or a reactive one (retaliatory action). If the action is a proactive action the next field is the probability of the sending actor taking the proactive action and if the action is a reactive one the next field is the hostility of the sending actor towards the receiving actor instead.

Also if an action, which was started previously, ends in a particular time period a similar entry is made into the time summary file with the key words END ACTION instead of START ACTION.

For a sample file see timeSummaryOutput.txt in the Sample Files folder shipped with CORES.

- HostilityMatFile

This is the name of the file to which the actor hostility matrix for every time period is printed.

The first set of entries in this file looks like:

Israel  
Hamas  
Palestinians  
United States

These are the row labels, each label indicating an actor name. Each label is on a new line.

The next set of entries (separated by a blank line from the first set) looks like:

Israel  
Hamas  
Palestinians  
United States

These are the column labels, each label indicating an actor name. Each label is on a new line.

If the “print names” flag in the Output Flags Section of the Configuration file is set to true then the next set of entries (separated by a blank line from the previous set) will look like:

```
Run:1 TimePeriod:1
Israel,Hamas,Palestinians,United States
Israel,0,-0.8,-0.8,0
Hamas,-0.8,0,0,-0.4
Palestinians,-0.8,0,0,0
United States,0,-0.6,0,0
```

If the flag is set to false then it looks like:

```
0,-0.8,-0.8,0
-0.8,0,0,-0.4
-0.8,0,0,0
0,-0.6,0,0
```

In the former case, the run number, time period, row labels, column labels and hostility values are printed. In the latter case only the hostility values are printed. These values are comma separated and should be interpreted as the hostility that the row actor has towards the column actor. This matrix is printed for every time period for every run in the simulation.

NOTE: The first two set of entries are really not very useful and if the user wants can ignore them for the parsers he or she writes to process the output.

For a sample file see hostilityMatOutput.txt in the Sample Files folder shipped with CORES.

- InfluenceMatFile

This is the name of the file to which the actor influence matrix for every time period is printed.

The first set of entries in this file looks like:

```
Israel
Hamas
Palestinians
United States
```

These are the row labels, each label indicating an actor name. Each label is on a new line.

The next set of entries (separated by a blank line from the first set) looks like:

Israel  
Hammas  
Palestinians  
United States

These are the column labels, each label indicating an actor name. Each label is on a new line.

If the “print names” flag in the Output Flags Section of the Configuration file is set to true then the next set of entries (separated by a blank line from the previous set) will look like:

Run:1 TimePeriod:1  
Israel,Hamas,Palestinians,United States  
Israel,0.6,0,0,0.4  
Hamas,0,0.5,0.5,0  
Palestinians,0,0.3,0.65,0.05  
United States,0.3,0,0.1,0.6

If the flag is set to false then it looks like:

0.6,0,0,0.4  
0,0.5,0.5,0  
0,0.3,0.65,0.05  
0.3,0,0.1,0.6

In the former case, the run number, time period, row labels, column labels and influence values are printed. In the latter case only the influence values are printed. These values are comma separated and should be interpreted as the influence that the column actor has on the row actor. This matrix is printed for every time period for every run in the simulation.

NOTE: The first two set of entries are really not very useful and, if the user wants, can be ignored for parsers to process the output.

For a sample file see influenceMatOutput.txt in the Sample Files folder shipped with CORES.

- BeliefsMatFile

This is the name of the file to which the beliefs matrix for every time period is printed.

The first set of entries in this file looks like:

Israel  
Hamas

Palestinians  
United States

These are the row labels, each label indicating an actor name. Each label is on a new line.

The next set of entries (separated by a blank line from the first set) looks like:

Israel General Military Action in Palestine  
Israel Targeted Military Action Against Palestinian Government  
Israel Targeted Military Action Against Hamas  
Hamas Suicide Bombing Against Israel  
Hamas Assassinate Israeli Leaders  
Palestinians Civil Disturbance  
USA Provide Material Support To Israel  
USA Provide Material Support To Palestinians  
Palestinians Provide Support To Hamas  
Israel Call for support from US  
Hamas Call For Change In Palestinian Leadership  
Palestinians Call For Support From US  
USA Call For Multilateral Peace Talks With Palestinians and Israel

These are the column labels, each label indicating an action name. Each label is on a new line.

If the “print names” flag in the Output Flags Section of the Configuration file is set to true then the next set of entries (separated by a blank line from the previous set) will look like:

Run:1 TimePeriod:1  
Israel General Military Action in Palestine,Israel Targeted Military Action Against  
Palestinian Government,Israel Targeted Military Action Against Hamas,Hamas Suicide  
Bombing Against Israel,Hamas Assassinate Israeli Leaders,Palestinians Civil  
Disturbance,USA Provide Material Support To Israel,USA Provide Material Support To  
Palestinians,Palestinians Provide Support To Hamas,Israel Call for support from  
US,Hamas Call For Change In Palestinian Leadership,Palestinians Call For Support From  
US,USA Call For Multilateral Peace Talks With Palestinians and Israel  
Israel,0.52,0.52,0.7,0.4,0.4,0.4,0.4,0.4,0.4,0.46,0.4,0.4,0.4  
Hamas,0.5,0.5,0.5,0.8,0.55,0.5,0.5,0.5,0.5,0.5,0.55,0.5,0.5  
Palestinians,0.35,0.35,0.35,0.35,0.35,0.61,0.35,0.35,0.61,0.35,0.35,0.48,0.35  
United States,0.4,0.4,0.4,0.4,0.4,0.4,0.4,0.64,0.46,0.4,0.4,0.4,0.7

If the flag is set to false then it looks like:

0.52,0.52,0.7,0.4,0.4,0.4,0.4,0.4,0.4,0.4,0.46,0.4,0.4,0.4  
0.5,0.5,0.5,0.8,0.55,0.5,0.5,0.5,0.5,0.5,0.55,0.5,0.5  
0.35,0.35,0.35,0.35,0.35,0.61,0.35,0.35,0.61,0.35,0.35,0.48,0.35

0.4,0.4,0.4,0.4,0.4,0.4,0.4,0.64,0.46,0.4,0.4,0.4,0.4,0.7

In the former case, the run number, time period, row labels, column labels and belief values are printed. In the latter case only the belief values are printed. These values are comma separated and should be interpreted as the belief that the row actor has in a column action. This matrix is printed for every time period for every run in the simulation.

NOTE: The first two set of entries are really not very useful and if the user wants can ignore them for the parsers he or she writes to process the output.

For a sample file see beliefsOutput.txt in the Sample Files folder shipped with CORES.

- ActionTendFile

This is the name of the file to which the actor's action tendencies every time period are printed.

The first set of entries in this file looks like:

Israel  
Hamas  
Palestinians  
United States

These are the row labels, each label indicating an actor name. Each label is on a new line.

The next set of entries (separated by a blank line from the first set) looks like:

Israel General Military Action in Palestine  
Israel Targeted Military Action Against Palestinian Government  
Israel Targeted Military Action Against Hamas  
Hamas Suicide Bombing Against Israel  
Hamas Assassinate Israeli Leaders  
Palestinians Civil Disturbance  
USA Provide Material Support To Israel  
USA Provide Material Support To Palestinians  
Palestinians Provide Support To Hamas  
Israel Call for support from US  
Hamas Call For Change In Palestinian Leadership  
Palestinians Call For Support From US  
USA Call For Multilateral Peace Talks With Palestinians and Israel

These are the column labels, each label indicating an action name. Each label is on a new line.

If the “print names” flag in the Output Flags Section of the Configuration file is set to true then the next set of entries (separated by a blank line from the previous set) will look like:

Run:1 TimePeriod:1

Israel General Military Action in Palestine,Israel Targeted Military Action Against  
Palestinian Government,Israel Targeted Military Action Against Hamas,Hamas Suicide  
Bombing Against Israel,Hamas Assassinate Israeli Leaders,Palestinians Civil  
Disturbance,USA Provide Material Support To Israel,USA Provide Material Support To  
Palestinians,Palestinians Provide Support To Hamas,Israel Call for support from  
US,Hamas Call For Change In Palestinian Leadership,Palestinians Call For Support From  
US,USA Call For Multilateral Peace Talks With Palestinians and Israel  
Israel,0.2,0.2,0.5,0,0,0,0,0,0.1,0,0,0  
Hamas,0,0,0,0.6,0.1,0,0,0,0,0.1,0,0  
Palestinians,0,0,0,0,0.4,0,0,0.4,0,0,0.2,0  
United States,0,0,0,0,0,0.4,0.1,0,0,0,0,0.5

If the flag is set to false then it looks like:

0.2,0.2,0.5,0,0,0,0,0,0.1,0,0,0  
0,0,0,0.6,0.1,0,0,0,0,0.1,0,0  
0,0,0,0,0.4,0,0,0.4,0,0,0.2,0  
0,0,0,0,0,0.4,0.1,0,0,0,0,0.5

In the former case, the run number, time period, row labels, column labels and action tendency values are printed. In the latter case only the action tendency values are printed. These values are comma separated and should be interpreted as the tendency of the row actor to take a column action. This matrix is printed for every time period for every run in the simulation.

NOTE: The first two set of entries are really not very useful and if the user wants can ignore them for the parsers he or she writes to process the output.

For a sample file see actionTendOutput.txt in the Sample Files folder shipped with CORES.

- ProbActionMatFile

This is the name of the file to which the action probabilities for every time period are printed. This is the probability of an actor taking an action based on the proactivity rationale.

The first set of entries in this file looks like:

Israel  
Hamas

Palestinians  
United States

These are the row labels, each label indicating an actor name. Each label is on a new line.

The next set of entries (separated by a blank line from the first set) looks like:

Israel General Military Action in Palestine  
Israel Targeted Military Action Against Palestinian Government  
Israel Targeted Military Action Against Hamas  
Hamas Suicide Bombing Against Israel  
Hamas Assassinate Israeli Leaders  
Palestinians Civil Disturbance  
USA Provide Material Support To Israel  
USA Provide Material Support To Palestinians  
Palestinians Provide Support To Hamas  
Israel Call for support from US  
Hamas Call For Change In Palestinian Leadership  
Palestinians Call For Support From US  
USA Call For Multilateral Peace Talks With Palestinians and Israel

These are the column labels, each label indicating an action name. Each label is on a new line.

If the “print names” flag in the Output Flags Section of the Configuration file is set to true then the next set of entries (separated by a blank line from the previous set) will look like:

Run:1 TimePeriod:1  
Israel General Military Action in Palestine,Israel Targeted Military Action Against  
Palestinian Government,Israel Targeted Military Action Against Hamas,Hamas Suicide  
Bombing Against Israel,Hamas Assassinate Israeli Leaders,Palestinians Civil  
Disturbance,USA Provide Material Support To Israel,USA Provide Material Support To  
Palestinians,Palestinians Provide Support To Hamas,Israel Call for support from  
US,Hamas Call For Change In Palestinian Leadership,Palestinians Call For Support From  
US,USA Call For Multilateral Peace Talks With Palestinians and Israel  
Israel,0.196248,0.189152,0.376074,0,0,0,0,0,0.238526,0,0,0  
Hamas,0,0,0,0.54065,0.33952,0,0,0,0,0.119831,0,0  
Palestinians,0,0,0,0,0,0.382845,0,0,0.382845,0,0,0.23431,0  
United States,0,0,0,0,0,0.290702,0.250387,0,0,0,0,0.45891

If the flag is set to false then it looks like:

0.196248,0.189152,0.376074,0,0,0,0,0,0.238526,0,0,0  
0,0,0,0.54065,0.33952,0,0,0,0,0.119831,0,0  
0,0,0,0,0,0.382845,0,0,0.382845,0,0,0.23431,0

0,0,0,0,0,0,0.290702,0.250387,0,0,0,0,0.45891

In the former case, the run number, time period, row labels, column labels and action probabilities are printed. In the latter case only the action probabilities are printed. These probabilities are comma separated and should be interpreted as the probability of the row actor taking a column action. This matrix is printed for every time period for every run in the simulation.

NOTE: The first two set of entries are really not very useful and if the user wants can ignore them for the parsers he or she writes to process the output.

For a sample file see probActionMatOutput.txt in the Sample Files folder shipped with CORES.

- ActBenefitMatFile

This is the name of the file to which the action benefit matrix is printed. The action benefit matrix denotes how beneficial an action is to the actor in terms of getting the actor closer to its goals.

The first set of entries in this file looks like:

Israel  
Hamas  
Palestinians  
United States

These are the row labels, each label indicating an actor name. Each label is on a new line.

The next set of entries (separated by a blank line from the first set) looks like:

Israel General Military Action in Palestine  
Israel Targeted Military Action Against Palestinian Government  
Israel Targeted Military Action Against Hamas  
Hamas Suicide Bombing Against Israel  
Hamas Assassinate Israeli Leaders  
Palestinians Civil Disturbance  
USA Provide Material Support To Israel  
USA Provide Material Support To Palestinians  
Palestinians Provide Support To Hamas  
Israel Call for support from US  
Hamas Call For Change In Palestinian Leadership  
Palestinians Call For Support From US  
USA Call For Multilateral Peace Talks With Palestinians and Israel

These are the column labels, each label indicating an action name. Each label is on a new line.

If the “print names” flag in the Output Flags Section of the Configuration file is set to true then the next set of entries (separated by a blank line from the previous set) will look like:

Run:1 TimePeriod:1

Israel General Military Action in Palestine,Israel Targeted Military Action Against  
Palestinian Government,Israel Targeted Military Action Against Hamas,Hamas Suicide  
Bombing Against Israel,Hamas Assassinate Israeli Leaders,Palestinians Civil  
Disturbance,USA Provide Material Support To Israel,USA Provide Material Support To  
Palestinians,Palestinians Provide Support To Hamas,Israel Call for support from  
US,Hamas Call For Change In Palestinian Leadership,Palestinians Call For Support From  
US,USA Call For Multilateral Peace Talks With Palestinians and Israel  
Israel,0.0723644,0.0697479,0.103015,0,0.0661409,0.0667576,0.0889603,0.0886239,0.07  
49808,0.0994262,0.0811483,0.0960996,0.0927355  
Hamas,0.0455492,0.0296314,0.078609,0.164075,0.149871,0.186972,0.0538754,0.05779  
36,0.106771,0,0.0528958,0.0553447,0.0186115  
Palestinians,0,0.0374532,0.0299625,0.183521,0.082397,0.101124,0.071161,0.071161,0.  
101124,0.0898876,0.082397,0.0786517,0.071161  
United  
States,0.121048,0.0729111,0.0949646,0,0.0635971,0.0408942,0.0749485,0.0898151,0.0  
47723,0.106294,0.0830982,0.0965319,0.108174

If the flag is set to false then it looks like:

0.0723644,0.0697479,0.103015,0,0.0661409,0.0667576,0.0889603,0.0886239,0.0749808  
,0.0994262,0.0811483,0.0960996,0.0927355  
0.0455492,0.0296314,0.078609,0.164075,0.149871,0.186972,0.0538754,0.0577936,0.10  
6771,0,0.0528958,0.0553447,0.0186115  
0,0.0374532,0.0299625,0.183521,0.082397,0.101124,0.071161,0.071161,0.101124,0.089  
8876,0.082397,0.0786517,0.071161  
0.121048,0.0729111,0.0949646,0,0.0635971,0.0408942,0.0749485,0.0898151,0.047723,  
0.106294,0.0830982,0.0965319,0.108174

In the former case, the run number, time period, row labels, column labels and action benefit values are printed. In the latter case only the action benefit values are printed. These values are comma separated and should be interpreted as how beneficial is the column action for the row actor.

NOTE: Although this matrix is printed for every time period for every run in the simulation its value remains constant throughout, as of now. Latter versions might have different values for different time periods.

NOTE: The first two set of entries are really not very useful and if the user wants can ignore them for the parsers he or she writes to process the output.

For a sample file see actBenefitMatOutput.txt in the Sample Files folder shipped with CORES.

- ActorResourceFile

This is a special variable. It allows the printing of a specific actor's resources. The value for this variable has a special format. The format is ActorName;outputFile e.g. AAA;recourcesForAAA.txt. The ActorName part of the value MUST be exactly as it appears in the input files. If the actor's name is "Henry" in the input files, "henry" would be considered a different actor here. The output filename is the same as the other output filenames.

There should be an ActorResourceFile variable for EACH actor whose resources need to be printed. Each actor gets his own resource output file so if there are actors: Henry, Bob, Lisa, Sherry in the demo and the resources for each need to be printed, something like this would be necessary:

```
ActorResourceFile = Henry;henryRecFile.txt
ActorResourceFile = Bob;bobRecFile.txt
ActorResourceFile = Lisa;lisaRecFile.txt
ActorResourceFile = Sherry;sherryRecFile.txt
```

Note how the ActorResourceFile variable repeats.

The first set of entries in an actor resource file will look like:

```
Run Number,1
Time Period,1
 Hamas Money,0.000000
 Hamas Personnel,0.800000
 Hamas Weapons,0.500000
 Israeli Land,-1.000000
 Israeli Money,-1.000000
 Israeli Personnel,-1.000000
 Israeli Security,-1.000000
 Israeli Weapons,-1.000000
 Palestinian Land,-1.000000
 Palestinian Money,-1.000000
 Palestinian Personnel,-1.000000
 Palestinian Security,-1.000000
 US Money,-1.000000
 US Power in Region,-1.000000
```

Thus the run number, time period, resource names and values are printed. These entries are printed for every time period for every run.

For a sample file see HamasResources.txt in the Sample Files folder shipped with CORES.

## 5. System Requirements

CORES will run on any machine with any Microsoft OS, FreeBSD, or Linux. CORES is only limited by the memory and processor speed of the machine. A faster machine will enable cores to finish faster. A significant amount of matrix multiplication is performed in CORES so a 1.0 GHz or above processor with 256 MB of RAM is recommended.

## 6. Performance Characteristics

Table 1: Performance Characteristics

Actors	Resources	Goals	Actions	No of Runs	No of Time Periods	Running Time	Output Size
6	22	9	21	1	10	1.29 seconds	238KB
6	22	9	21	1	50	6.18 seconds	1.1MB
6	22	9	21	1	100	12.38 seconds	2.2MB
6	22	9	21	10	10	12.42 seconds	2.1MB
6	22	9	21	10	50	1 min 05 seconds	11MB
6	22	9	21	10	100	2 min 01 seconds	21MB
6	22	9	21	25	10	33 seconds	5.2MB
6	22	9	21	25	50	2 min 39 seconds	26MB
6	22	9	21	25	100	5 min 13 seconds	52MB

## 7. Illustrative Samples

### 7.1 Execute Sample Scenario

Here is an example of how to setup and run a scenario with CORES. The input data for this scenario is found in Appendix A. This example shows how to configure and run cores for FILE based input. However, scripts to create a mysql database with the same input are available in Appendix B.

The first thing that must be done is to create the input files and configure CORES. Copy the data from each table in Appendix A into individual files. Put these files into a directory. Use the path to this directory as the “input directory” variable in the config file. Create a directory for output and add its path to the config file for the “output directory” variable. Add each filename to the corresponding variable under the “INPUT FILE PATHS” section of the config file. Set the number of runs and time periods in the config file. Don’t forget to use FILES as the “input type” variable. Also be sure to select the outputs.

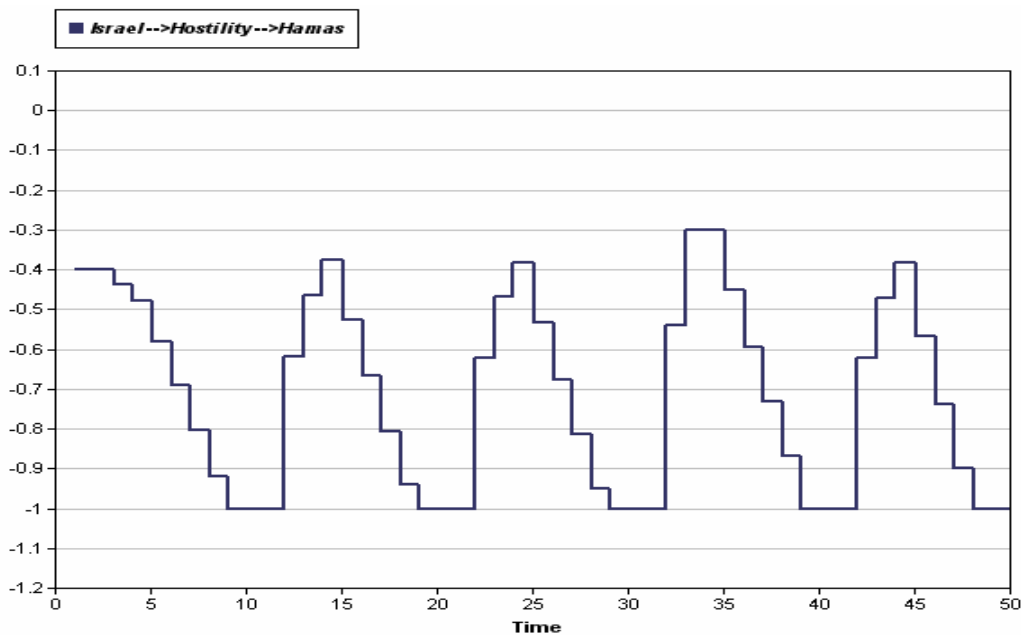
To run CORES either drag and drop the config file onto the CORES executable or run cores from the command line and pass the path to the config file as a parameter.

CORES will run showing output in the console window. When it is finished all of its output along with a copy of the config file will be found in the directory pointed to by the “output directory” variable. These files can be processed by another application or they can be opened and viewed in any text editor.

## 7.2 Explanation of Results

Here is an explanation of certain output from the above scenario.

In a typical scenario, as actors interact they will become hostile towards each other at certain time periods. When the hostility becomes too great they will take actions towards the actors whom they are hostile to. After hostile actions are taken the hostility level will subside and they return to the normal action taking sequence. Below is a figure, from a sample scenario, showing how hostility towards Hamas oscillates for Israel



**Figure 4: Israeli Hostility Towards Hamas**

The actors have beliefs in actions. As time passes the beliefs in actions will change depending on how the simulation is going. The figure below shows Israel’s belief in asking the US for help grow and surpass Israel’s belief in attacking Hamas directly.

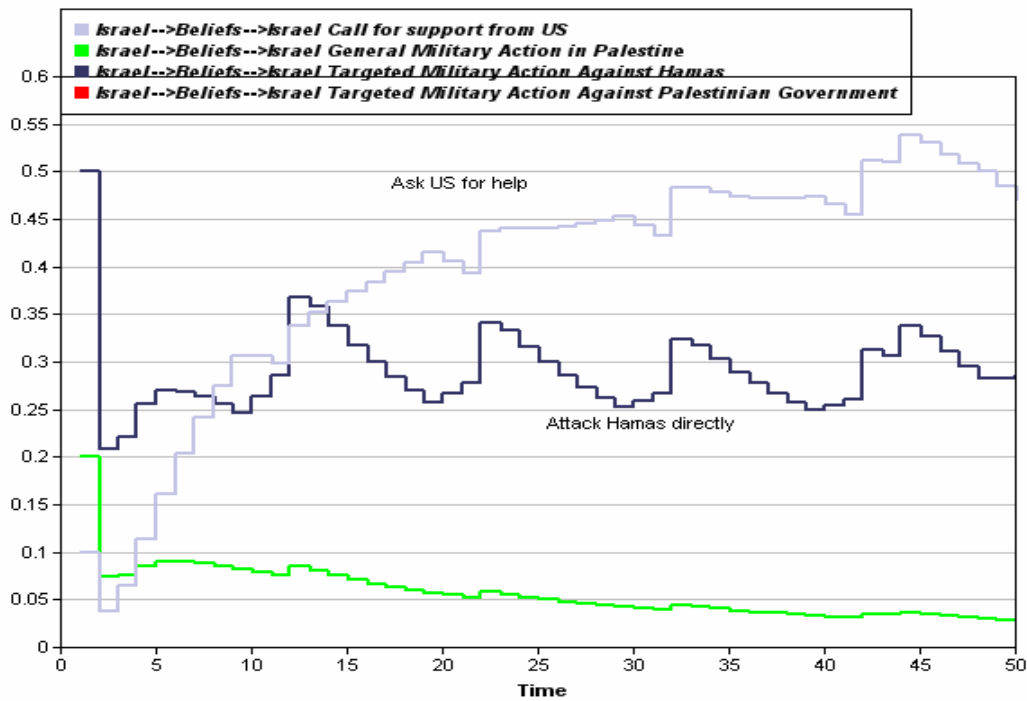


Figure 5: Israeli Belief in Israeli Actions

## 8. Sample Input

Table 2: Influence:

START MATRIX	Israel	Hamas	Palestinians	United States	Regional Arab Powers	United Nations
Israel	0.6	0	0	0.4	0	0
Hamas	0	0.4	0.3	0	0.3	0
Palestinians	0	0.2	0.55	0.05	0.2	0
United States	0.2	0	0.1	0.5	0	0.2
Regional Arab Powers	0	0.3	0.2	0.1	0.4	0
United Nations	0	0	0.1	0.4	0	0.5

Table 3: Hostility:

START MATRIX	Israel	Hamas	Palestinians	United States	Regional Arab Powers	United Nations
Israel	0	-0.4	-0.4	0	-0.2	0
Hamas	-0.4	0	0	-0.2	0	-0.2
Palestinians	-0.3	0	0	0	0	0
United States	0	-0.2	0	0	-0.1	0
Regional Arab Powers	-0.2	0	0	-0.1	0	0
United Nations	0	-0.2	0	0	0	0

Table 4: Volatility:

START MATRIX	Volatility
Israel	0.8

Hamas	0.8
Palestinians	0.2
United States	0.8
Regional Arab Powers	0.5
United Nations	0.5

Table 5: Tension Threshold:

START MATRIX	tension Threshold
Israel	0.8
Hamas	0.8
Palestinians	0.8
United States	0.8
Regional Arab Powers	0.8
United Nations	0.8

Table 6: Pause Injections:

START MATRIX	Actor	Action Name	Resource Name	value
0	INJECTION	20	Hamas	Hamas Call For Change In Palestinian Leadership

Table 7: Goal x Effect:

START MATRIX	Israeli Money	Israeli Weapons	Israeli Land	Israeli Security	Israeli Personnel	Palestinian Money
Stop Terrorism	0.2	0.2		0.4		
Maintain Israel-US Relations				0.3		
Minimize Israeli Casualties					1	
Weaken Israel	-0.5	-0.5	-0.5	-0.5	-0.5	
Maximize Arab Influence						
Achieve Palestinian Sovereignty	-0.2	-0.2				
Maximize US Influence			0.5			
Minimize Palestinian Casualties						
Maximize UN Influence						

Palestinian Land	Palestinian Security	Palestinian Living Conditions	Palestinian Personnel	Palestinian Sovereignty	US Money
				-0.2	
0.4					
0.4	0.2	0.2		1	
			1		

US Personnel	US Power in Region	Regional Arab Power Money	Regional Arab Power Personnel	Arab Power in Region
0.3	0.3			-0.3
	-0.3			0.5
				1
	1			



Table 8: Actor Resource:

START MATRIX	Israeli Money	Israeli Money Growth	Israeli Weapons	Israeli Weapons Growth	Israeli Land	Israeli Land Growth	Israeli Security	Israeli Security Growth
Israel	0.5	0.001	0.8	0.001	0.5	0	0.5	0
Hamas	-1	0	-1	0	-1	0	-1	0
Palestinians	-1	0	-1	0	-1	0	-1	0
United States	-1	0	-1	0	-1	0	-1	0
Regional Arab Powers	-1	0	-1	0	-1	0	-1	0
United Nations	-1	0	-1	0	-1	0	-1	0

Israeli Personnel	Israeli Personnel Growth	Palestinian Money	Palestinian Money Growth	Palestinian Land	Palestinian Land Growth	Palestinian Security
1	0.001	-1	0	-1	0	-1
-1	0	-1	0	-1	0	-1
-1	0	0.2	0.0002	0.5	0	0.5
-1	0	-1	0	-1	0	-1
-1	0	-1	0	-1	0	-1
-1	0	-1	0	-1	0	-1

Palestinian Security Growth	Palestinian Living Conditions	Palestinian Living Conditions Growth	Palestinian Personnel	Palestinian Personnel Growth	Palestinian Sovereignty
0	-1	0	-1	0	-1
0	-1	0	-1	0	-1
0	0.2	0	1	0.001	0
0	-1	0	-1	0	-1
0	-1	0	-1	0	-1
0	-1	0	-1	0	-1

Palestinian Sovereignty Growth	US Money	US Money Growth	US Personnel	US Personnel Growth	US Power in Region	US Power in Region Growth	Regional Arab Power Money
0	-1	0	-1	0	-1	0	-1
0	-1	0	-1	0	-1	0	-1
0	-1	0	-1	0	-1	0	-1
0	1	0.004	1	0.003	0.5	0	-1
0	-1	0	-1	0	-1	0	0.8
0	-1	0	-1	0	-1	0	-1

Regional Arab Power Money Growth	Regional Arab Power Personnel	Regional Arab Power Personnel Growth	Arab Power in Region	Arab Power in Region Growth
0	-1	0	-1	0
0	-1	0	-1	0
0	-1	0	-1	0
0	-1	0	-1	0
0.003	1	0.001	0.5	0
0	-1	0	-1	0

Hammas Money	Hammas Money Growth	Hammas Weapons	Hammas Weapons Growth	Hammas Personnel	Hammas Personnel Growth	UN Money	UN Money Growth
-1	0	-1	0	-1	0	-1	0
0	0	0.5	0	0.8	0	-1	0
-1	0	-1	0	-1	0	-1	0
-1	0	-1	0	-1	0	-1	0
-1	0	-1	0	-1	0	-1	0
-1	0	-1	0	-1	0	0.5	0.001

UN Influence	UN Influence Growth
-1	0
-1	0
-1	0
-1	0
-1	0
-1	0
0.2	0

Table 9: Actor x Goal:

START MATRIX	Stop Terrorism	Maintain Israeli-US Relations	Minimize Israeli Casualties	Weaken Israel	Maximize Arab Influence	Achieve Palestinian Sovereignty
Israel	0.5	0.2	0.3	0	0	0
Regional Arab Powers	0	0	0	0	1	0
United States	0	0	0	0	0	0
United Nations	0	0	0	0	0	0
Palestinians	0	0	0	0	0	0
Hamas	0	0	0	0.8	0	0.2

Maximize US Influence	Minimize Palestinian Casualties	Maximize UN Influence
0	0	0
0	0	0
1	0	0
0	0	1
0	1	0
0	0	0

Table 10: Actor Tendencies:

START MATRIX	Israel General Military Action in Palestine	Israel Targeted Military Action Against Palestinian Government	Israel Targeted Military Action Against Hamas	Israel Call for support from US	Hamas Suicide Bombing Against Israel	Hamas Call For Change In Palestinian Leadership	Hamas Call For Support From Regional Arab Powers	Hamas Assassinate Israeli Leaders	Palestinians Call For Support From US
Israel	0.2	0.2	0.5	0.1					
Hamas					0.6	0.1	0.2	0.1	
Palestinians									0.2
United States									
Regional Arab Powers									
United Nations									

Palestinians Provide Support To Hammas	Palestinians Civil Disturbance	USA Call For Multilateral Peace Talks With Palestinians and Israel	USA Provide Material Support To Israel	USA Provide Material Support To Palestinians	USA Military Action Against Regional Arab Powers	Regional Arab Powers Call For Multilateral Peace Talks With Palestinians and Israel	Regional Arab Powers Provide Material Support To Palestinians	Regional Arab Powers Provide Military Support To Palestinians	UN Call For Internationall y Arbitrated Peace Talks	UN Send Peacekeeping Force To Palestine
0.4	0.4									
		0.5	0.3	0.1	0.1					
						0.2	0.4	0.4		
									1	0

UN Send Peacekeepin g Force To Israel
0

Table 11: Beliefs:

START MATRIX	Israel General Military Action in Palestine	Israel Targeted Military Action Against Palestinian Government	Israel Targeted Military Action Against Palestinian Government	Israel Call for support from US	Hamass Suicide Bombing Against Israel	Hamass Call For Change In Palestinian Leadership	Hamass Call For Support From Regional Arab Powers	Hamass Assassinate Israeli Leaders	Palestinians Call For Support From US	Palestinians Provide Support To Hamass
Israel	1	1	1	1	1	1	1	1	1	1
Hamass	1	1	1	1	1	1	1	1	1	1
Palestinians	1	1	1	1	1	1	1	1	1	1
United States	1	1	1	1	1	1	1	1	1	1
Regional Arab Powers	1	1	1	1	1	1	1	1	1	1
United Nations	1	1	1	1	1	1	1	1	1	1

	USA Call For Multilateral Peace Talks With Palestinians and Civil Disturbance	USA Provide Material Support To Israel	USA Provide Material Support To Palestinians	USA Military Action Against Regional Arab Powers	Regional Arab Powers Call For Multilateral Peace Talks With Palestinians and Israel	Regional Arab Powers Provide Material Support To Palestinians	Regional Arab Powers Provide Military Support To Palestinians	UN Call For International y Arbitrated Peace Talks	UN Send Peacekeeping Force To Palestine
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1

UN Send Peacekeeping Force To Israel	
	1
	1
	1
	1
	1
	1
	1

START MATRIX	Israeli Money	Israeli Weapons	Israeli Land	Israeli Security	Israeli Personnel
Israel General Military Action in Palestine	-0.08	-0.12	0.25	0.3	-0.15
Israel Targeted Military Action Against Palestinian Government	-0.06	-0.09	0.1	0.2	-0.1
Israel Targeted Military Action Against Hamas	-0.06	-0.09	0	0.2	-0.1
Israel Call for support from US	0.03	0.03	0	0	0.1
Hamas Suicide Bombing Against Israel	-0.02	-0.02	-0.05	-0.1	-0.1
Hamas Call For Change In Palestinian Leadership	0	0	0	0	0
Hamas Call For Support From Regional Arab Powers	0	0	0	0	0
Hamas Assassinate Israeli Leaders	-0.04	-0.02	0	-0.15	-0.1
Palestinians Call For Support From US	0	0	0	0	0
Palestinians Provide Support To Hamas	0	0	0	-0.1	0
Palestinians Civil Disturbance	-0.01	-0.015	-0.1	-0.1	-0.1
USA Call For Multilateral Peace Talks With Palestinians and Israel	0	0	0	0.1	0
USA Provide Material Support To Israel	0.04	0.02	0	0	0
USA Provide Material Support To Palestinians	0	0	0	0	0
USA Military Action Against Regional Arab Powers	0	0	0	0.3	0
Regional Arab Powers Call For Multilateral Peace Talks With Palestinians and Israel	0	0	0	0.1	0
Regional Arab Powers Provide Material Support To Palestinians	0	0	0	0	0
Regional Arab Powers Provide Military Support To Palestinians	0	0	0	0	0
UN Call For Internationally Arbitrated Peace Talks	0	0	0	0.1	0
UN Send Peacekeeping Force To Palestine	0	0	0	0.1	0
UN Send Peacekeeping Force To Israel	-0.02	-0.02	0	0.1	-0.1

Table 12: Action x Effect:

Palestinian Money	Palestinian Land	Palestinian Security	Palestinian Living Conditions	Palestinian Personnel	Palestinian Sovereignty	US Money	US Personnel
-0.02	0.25	-0.5	-0.5	-0.5	-0.5	0	0
-0.01	-0.1	-0.3	-0.3	-0.3	-0.3	0	0
-0.005	0	-0.3	-0.3	-0.1	-0.3	0	0
0	0	0	0	0.1	0	-0.06	0
0	0.1	-0.1	0	0	0	-0.01	0
-0.01	0	-0.1	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0.1	0	0	0	-0.01	0
0.015	0	0	0.1	0.1	0	-0.015	0
-0.04	0	-0.1	0	0.1	0	0	0
-0.02	0.1	-0.1	-0.2	0.1	0	0	0
0	0	0.1	0	0	0.1	0	0.1
0	0	0	0	0	0	-0.06	0.1
0.02	0	0.1	0.2	0	0.1	-0.02	0.1
-0.04	0	0	0	0	0	-0.2	-0.5
0	0	0.1	0	0	0.1	0	0
0.4	0	0	0.1	0.1	0	0	0
0.06	0	0	0	0	0	0	0
0	0	0.1	0	0	0.1	-0.01	0
-0.02	0	0.2	0	0	0.1	-0.02	-0.1
0	0	0.2	0	0	0.2	-0.02	-0.1

US Power in Region	Regional Arab Power Money	Regional Arab Power Personnel	Arab Power in Region	Hamas Money	Hamas Weapons
0.2	0	0	-0.2	-0.06	-0.06
0	0	0	0	-0.01	-0.02
0	0	0	0	-0.06	-0.06
0.2	0	0	-0.2	0	0
0	0	0	0	0	-0.005
0.1	0	0	0	0	0
-0.2	-0.06	0	0.2	0.03	0.03
0	0	0	0	0	-0.03
0.1	0	0	-0.1	0	0
-0.1	0	0	0.1	0.03	0.01
-0.1	0	0	0.1	0	0
0.2	0	0	-0.2	0	0
0	0	0	0	0	0
0.1	0	0	-0.1	0	0
0.3	-0.15	-0.8	-0.3	0	0
-0.2	-0.03	0.1	0.2	0	0
0	-0.06	0.1	0.1	0.01	0.01
0	-0.09	0	0.2	0.015	0.015
-0.1	0	0	0.1	0	0
0.1	0	0	-0.1	0	0
0	0	0	0	0	0

Hamas Personnel	UN Money	UN Influence
0.2	-0.01	-0.5
0.2	-0.01	-0.3
-0.2	-0.01	-0.3
0	0	0
1	0	0
0.1	0	0
0.1	0	0
0.1	0	0
-0.1	0	0
0.1	0	-0.1
0.1	0	-0.1
0	0.01	0.1
0	0	0
0	0	0
0	-0.2	-0.5
0	0	0
0.1	0	0
0.1	0	0
0	0.05	0.1
0	-0.01	0.2
0	-0.1	0.3

START MATRIX				
Israel General Military Action in Palestine	Military	3	Israel	
Israel Targeted Military Action Against Palestinian Government	Military	3	Israel	
Israel Targeted Military Action Against Hamas	Military	3	Israel	
Israel Call for support from US	Diplomatic	1	Israel	
Hamas Suicide Bombing Against Israel	Military	2	Hamas	
Hamas Call For Change In Palestinian Leadership	Diplomatic	1	Hamas	
Hamas Call For Support From Regional Arab Powers	Diplomatic	1	Hamas	
Hamas Assassinate Israeli Leaders	Military	3	Hamas	
Palestinians Call For Support From US	Diplomatic	1	Palestinians	
Palestinians Provide Support To Hamas	Financial Economic	3	Palestinians	
Palestinians Civil Disturbance	Military	3	Palestinians	
USA Call For Multilateral Peace Talks With Palestinians and Israel	Diplomatic	1	United States	
USA Provide Material Support To Israel	Military	7	United States	
USA Provide Material Support To Palestinians	Military	7	United States	
USA Military Action Against Regional Arab Powers	Military	7	United States	
Regional Arab Powers Call For Multilateral Peace Talks With Palestinians and Israel	Diplomatic	1	Regional Arab Powers	
Regional Arab Powers Provide Material Support To Palestinians	Financial Economic	7	Regional Arab Powers	
Regional Arab Powers Provide Military Support To Palestinians	Military	7	Regional Arab Powers	
UN Call For Internationally Arbitrated Peace Talks	Diplomatic	1	United Nations	
UN Send Peacekeeping Force To Palestine	Military	7	United Nations	
UN Send Peacekeeping Force To Israel	Military	7	United Nations	

Table 13: Action Details:

receiver 1	receiver 2	receiver 3	receiver 4	receiver 5
Palestinians	United States	Hamas	United Nations	
Palestinians	Hamas	United Nations		
Hamas	United Nations	Palestinians		
United States	Regional Arab Powers	Palestinians		
Israel	United States	Palestinians		
Palestinians	United States			
Regional Arab Powers				
Israel	United States	Palestinians		
United States	Hamas	Regional Arab Powers		
Hamas	United Nations	United States	Israel	Regional Arab Powers
United States	United Nations	Hamas	Israel	Regional Arab Powers
United Nations	Regional Arab Powers	Palestinians	Israel	
Israel				
Palestinians	Regional Arab Powers			
Regional Arab Powers	Palestinians	United Nations	Israel	
Palestinians	Israel	United States		
Palestinians	Hamas			
Palestinians	Hamas			
Israel	Palestinians	Regional Arab Powers	United States	
Palestinians	Israel	Regional Arab Powers	United States	
Israel	Palestinians	United States		

START MATRIX						
Israel General Military Action in Palestine	Israeli Money	Israeli Weapons	Israeli Land	Israeli Security	Israeli Personnel	Palestinian Money
Israel Targeted Military Action Against Palestinian Government	0.08	0.12			0.15	
Israel Targeted Military Action Against Hamas	0.06	0.09			0.1	
Israel Call for support from US	0.06				0.1	
Hamas Suicide Bombing Against Israel					0.05	
Hamas Call For Change In Palestinian Leadership						
Hamas Call For Support From Regional Arab Powers						
Hamas Assassinate Israeli Leaders						
Palestinians Call For Support From US						0.005
Palestinians Provide Support To Hamas						0.04
Palestinians Civil Disturbance						0.02
USA Call For Multilateral Peace Talks With Palestinians and Israel						
USA Provide Material Support To Israel						
USA Provide Material Support To Palestinians						
USA Military Action Against Regional Arab Powers						
Regional Arab Powers Call For Multilateral Peace Talks With Palestinians and Israel						
Regional Arab Powers Provide Material Support To Palestinians						
Regional Arab Powers Provide Military Support To Palestinians						
UN Call For Internationally Arbitrated Peace Talks						
UN Send Peacekeeping Force To Palestine						
UN Send Peacekeeping Force To Israel						

Table 14: Action x Resource Requirement:



START MATRIX	type	Actor	Action Name	Resource Name	value
0	ACTION INJECTION		100 Israel	Israel Targeted Military Action Against Hamas	
1	RESOURCE INJECTION		100 Palestinians	Palestinian Money	1000
2	ACTION INJECTION		2 Hamas	Hamas Call For Change In Palestinian Leadership	
END MATRIX					
unique num	RESOURCE INJECTION	time period	actor name	resource	delta value
unique num	ACTION INJECTION	time period	actor name	action name	
unique num	EFFECT INJECTION	time period	sending actor name	receiving actor name	effect name
unique num	PAUSE	time period	Now put the new injections you want to occur in the pauseInjections file.		

Table 15: Injected Actions: